Jan. 14, 1936. E. W. FRANCK 2,027,727

SOUND REPRODUCER

Filed June 28, 1934

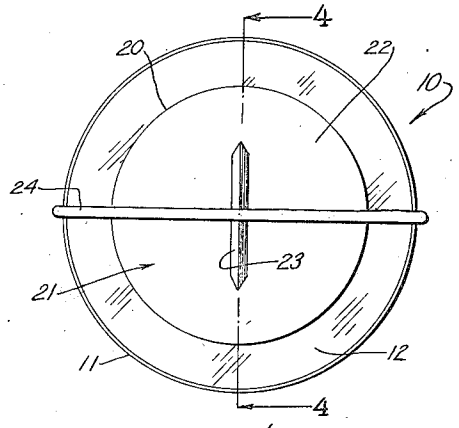


Fig. 1

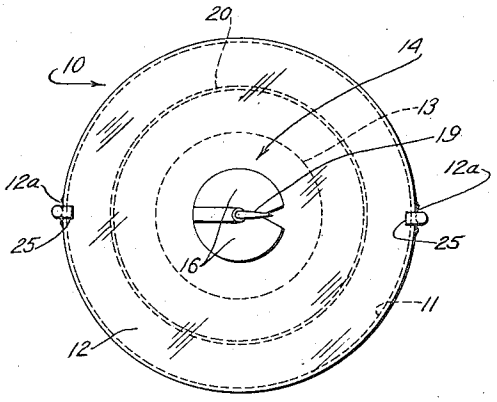


Fig. 2

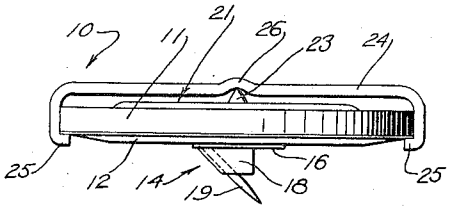


Fig. 3

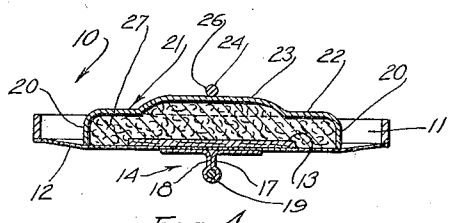


Fig. 4

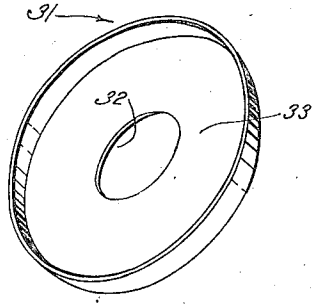


Fig. 6

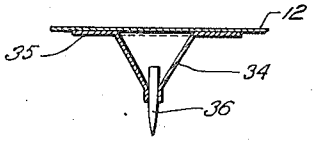


Fig. 8

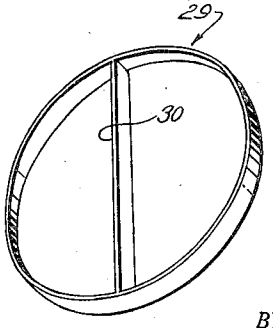


Fig. 5

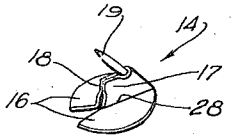


Fig. 7

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SOUND REPRODUCER

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Application June 28, 1934, Serial No. 732,795

20 Claims. (Cl. 274—27)

This invention relates to new and useful improvements in sound reproducing means and has particular relation to a means for reproducing sound from phonograph records.

Amongst its other objects the invention aims to provide a reproducer which is of simple and economical construction whereby it may be produced at low cost, and which will give a clear and loud reproduction of a record, and which may be light in weight.

Another object of the invention is to provide a sound reproducer which is completely self-contained and which is not dependent on the use of any horn or other air-column as a portion of its dampening means.

Other objects and advantages will become apparent from a consideration of the following detailed description taken in connection with the accompanying drawing wherein a satisfactory embodiment of the invention is shown. However, it will be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

In the drawing:

Fig. 1 is a top plan view of the reproducer;

Fig. 2 is a bottom plan view thereof;

Fig. 3 is an edge view looking from the lower side of Fig. 1;

Fig. 4 is a sectional view taken substantially along the line 4—4 of Fig. 1;

Fig. 5 is a perspective view showing a slightly modified form of diaphragm stretching means employed;

Fig. 6 is a similar view showing a further modified form of said means;

Fig. 7 is a perspective view of a stylus holder; and

Fig. 8 is a detail sectional view showing a slight modification of diaphragm.

In the drawing, my improved reproducer is generally designated 10 and as shown comprises a diaphragm supporting means 11 in the form of an annulus. A diaphragm disc 12 has its edge portion secured in any suitable manner to the supporting ring or annulus 11 and as shown the said diaphragm is of celluloid although any other suitable material may be used. Against any selected portion of one side of the disc 12 there is secured, as by a suitable adhesive, a plate 13 of relatively thin wood. If desired, the plate 13 may be of material other than wood as, for example, it may be of relatively stiff celluloid or any other material which will stiffen the portion of disc 12 to establish a piston motion when oscillating forces are applied to it by means of a stylus as will later appear.

To the side of the diaphragm opposite the plate 13 there is secured a stylus holder generally designated 14 and which may be bent up from sheet metal. This stylus holder includes base portions 16 and portions 17 and 18 extending at right angles to the base portions 16. The base portions 16 are suitably secured as by cement or glue to the central portion of the disc 12 and a stylus 19 is held between the portions 17 and 18 of the holder. The said stylus is mounted by inserting its blunt end between the holder portions 17 and 18 and then pinching or squeezing said portions together against the stylus. If desired, a drop of adhesive may be used to further secure the stylus in place and to secure the holder portions 17 and 18 together.

In the manufacture of the improved reproducer the plate 13 may be secured to the central portion of the celluloid disc 12 and thereafter the holder 14 containing the stylus 19 may be secured to either side of the diaphragm. This sub-assembly may then be secured to the supporting ring 11 by cementing or clamping the edge of the celluloid disc or diaphragm to one edge of said ring, it being understood that such sub-assembly constitutes a diaphragm with a stiffened or non-flexing center. If desired, the disc 12 may first be clamped to the supporting ring and thereafter the stiffening plate and stylus holder may be secured to the said disc.

In mounting the disc 12 on its support it is desirable to follow a method whereby all wrinkles are removed from the disc. Thereafter, the thin celluloid disc 12 is tensioned and this is accomplished by pressing the free edges of the walls 20 of a shallow dish or dome shaped member 21 against one side of said disc. In addition to the ring-like wall 20 the member 21 includes a closed outer wall 22 having a raised rib or bead 23 extending partly across the same and through its central portion. The member 21 is held against the disc 12 by means of a spring clip 24 here shown as comprising a wire or rod extending across the support 11 and having its end portions bent downwardly and then inwardly as at 25 so as to engage against the lower edge of said support 11. Intermediate its ends the clip 24 is pressed upwardly as at 26 to provide a slight notch in its lower side. This notch receives a portion of the rib 23 whereby to locate the member 21 in the desired position with respect to the support 11 and the disc 12 to further locate clip

24 the support 12 may be crimped at diametrically opposite points 12a to receive the arms of the clip.

It will be understood that the clip 24 being resilient or springy, presses the member 21 against the celluloid disc 12 whereby the latter is tensioned and its central portion within the wall 20 of the member 21 is in a flat stretched condition and of a diameter desired and in the operation of the diaphragm in the reproduction of a record this stretched central portion covered by disc 13 acts as a piston in the reproduction of vertically cut or hill-and-dale records. When the member 21 is not in place a very poor or low volume and indistinct reproduction may be obtained from a record. However, with the member 21 in place a loud metallic reproduction results and to overcome this I insert a damper 27 in a form of a piece of felt or the like into the member 21.

This means 27 is of compressible material and normally is of a thickness greater than the depth of the member 21 whereby when it is in said member and the member is clamped against the disc 12 the said damper is slightly compressed and is held against one side of the diaphragm. With means 27 in place highly satisfactory reproduction of the desired volume and clarity is obtained. However, the damping means may be other than that shown and may be in the form of a sheet of suitable material secured to the diaphragm by adhesive or may be held in place by a spring. Also, if desired the damping means may be applied to the diaphragm at the side thereof opposite to that on which the member 21 is located.

When the device is used for the reproduction of lateral cut records as distinguished from hill-and-dale records the line or bend 28 of the stylus support 14 represents a fulcrum to change the direction of the force of the lateral vibrations acting through the stylus with the result that the portions of the diaphragm at opposite sides of this line are rocked vertically in opposite directions as the stylus follows the recorded groove of the laterally cut record. To better adapt the reproducer for reproducing such records a shallow-cup-like member 29 (see Fig. 5) should be substituted for the member 21 of Figs. 1 through 4. This member 29 is in all respects similar to the member 21 with the exception that a partition 30 divides the interior of the member 29 into two parts or chambers and when the member 29 is in use its partition 30 is aligned with the stylus 19 and is pressing against the diaphragm.

Fig. 6 shows a further modification of a tensioning and damping means holder and in this figure the member generally designated 31 is a shallow cup-like member and differs from the member 21 previously described only in that the member 31 has an opening 32 through its outer or back wall portion 33. When the hole 32 is not overly large satisfactory reproduction may be obtained when using a member as 31. However, when the hole in the wall 33 is enlarged the quality and volume of reproduction is impaired as the size of the hole increases.

In the design of reproducers of this type considerable control over the performance may be exercised by varying the size and weight of this plate 13. It will be readily seen that if this plate is increased in diameter or size so that its edges approach the wall 20 of disc 21 then the diaphragm stiffness is greatly increased. On the other hand, if the disc is decreased in diameter or size, the diaphragm stiffness will be greatly decreased. Thus, by keeping all other dimensions constant, and varying the size of this plate 13 the effective stiffness of the diaphragm may be changed. It is a well known fact that a stretched diaphragm with a mass disposed at its center or about its center will have its own natural period of resonance. In general this resonance frequency may be increased by the use of stiffer diaphragm material, by increased stretch in the diaphragm, or, as I find it often convenient, by increasing the size of plate 13 as just explained.

The resonance frequency of a weighted and stretched diaphragm may also be controlled to a considerable extent by varying the mass of the central portion. Reducing this mass will result in an increased resonance frequency, and increasing this mass will lower the resonance frequency. In general I find it is advisable to keep the mass of the central portion reasonably small, and to control the resonance frequency to give the desired performance by selecting the proper size for disc 13 and adjusting the amount of stretch in the diaphragm.

Whenever a stretched diaphragm with central mass is agitated by a vibromotive force whose frequency is near to the resonant frequency of the stretched diaphragm, there is a tendency for the amplitude of the diaphragm excursions to become excessive and cause a buzzing which is very detrimental to the quality of reproduction. In the conventional reproducer this tendency towards buzzing when excited at frequencies close to resonance is usually counteracted by the dampening effect provided by the air-column load of a horn, megaphone, or ear tubes. Because of this effect, the ordinary type of reproducer is quite unsatisfactory when it is not used in conjunction with its horn or air-column load. Certain types of electro-magnetic load-speakers have been made with a diaphragm having large area and large effective mass. The large effective mass of this type diaphragm, together with the low stiffness of the material used resulted in very low resonance frequency. Besides having a relatively low resonance frequency, this type reproducer also has a large area so that a considerable air load is effective as a dampener although there is no air-column as the term is generally used.

In my device, I control this tendency towards too great freedom at the resonance frequency without the use of the usual air-column load, and without resorting to a diaphragm of low stiffness and/or great area. The novel means I use will be understood by refeernce to Figs. 1 through 4 and will be seen most clearly by reference to Fig. 4. Here is shown dome-shaped member 21 with wall 20 held against one face of the diaphragm disc 12. It will be seen that with the damping material 27, held in engagement with one face of the diaphragm 12 as before described the entire area of the diaphragm within the wall 20 which is engaged by the dampening material is effectively uniformly loaded in the sense that each element of area of the diaphragm within the wall 20 must actually do work on the damping material as it vibrates. I find that the best damping materials for use here are certain kinds of sponge rubber and certain types of woolen fabric.

Fig. 8 shows a modified construction of means for stiffening the central portion of the disc 12 so as to have such portion function with a piston-like movement. In the figure a cone shaped sheet

metal piece 34 having a relatively large diameter flange 35 is secured to the disc 12. The flange is cemented or otherwise secured to the disc and stiffens the latter and the cone has a stylus 36 secured thereto as shown.

In some forms of my invention I make use of still another form of damping, which, while usually not sufficient in itself to control the diaphragm at resonance, is of distinct benefit when used in combination with the method of diaphragm loading described immediately above. When a closed member as 21 is employed and the free edge of its wall 20 is pressed tight against the disc 12 a seal is established and any movement of the diaphragm results in compression and expansion of the air in the member 21 and this constitutes a load on the diaphragm. This is true of course only when the cup or member 21 is shallow and closed at its back.

Having thus set forth the nature of my invention, what I claim is:

1. In a sound reproducer, a supporting means, a diaphragm comprising a sheet supported against said means, an annulus held tight against said sheet to produce a plane radial tension in the diaphragm, a stylus holder connected with said diaphragm, and damping means engaging the diaphragm within said annulus.

2. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm, tensioning means pressing the free edge of said member against the diaphragm to produce a plane radial tension in a central portion thereof, a stylus holder connected with the diaphragm, and damping means within said member against the diaphragm.

3. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow metal cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, tensioning means pressing the free edge of said member against the diaphragm, a stylus holder connected with the diaphragm, and damping means engaging the diaphragm.

4. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow rigid cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, tensioning means pressing the free edge of said member against the diaphragm, a stylus holder secured to the diaphragm, and damping means within said member against the diaphragm.

5. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow rigid cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, a spring clip spanning said supporting means and having its intermediate portion pressing against said member to press its free edge against the diaphragm and produce a plane radial tension in the latter, and a stylus holder connected with the diaphragm.

6. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, a spring clip spanning said supporting means and having its intermediate portion pressing against said member to press its free edge against the diaphragm and produce a plane radial tension in the latter, a stylus holder connected with the diaphragm, and a damping means within said member and pressed against the diaphragm thereby.

7. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, a rib on the outer surface of the back of said member, a spring clip spanning said supporting means and clipped thereto and having a notch intermediate its ends receiving a portion of said rib to locate said member with respect to the diaphragm, said clip pressing the free edge of said member against the diaphragm to produce a plane radial tension in the latter, and a stylus holder connected with the diaphragm.

8. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a stiffening member secured to and concentric with said diaphragm, a shallow rigid cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, tensioning means pressing the free edge of said member against the diaphragm to produce a plane radial tension in the latter, a stylus holder connected with the diaphragm, and damping means within said member against the diaphragm.

9. In a sound reproducer, a supporting means, a diaphragm supported at its edge by said means, a stiffening plate secured to the central portion of the diaphragm at one side thereof, a sheet metal stylus holder connected with the central portion of said diaphragm and including a flat portion secured to the opposite side of said diaphragm and a pair of portions projecting outwardly of the diaphragm, and a stylus secured between said outwardly projecting portions by being gripped between them.

10. In a sound reproducer, a supporting means, a diaphragm supported at its edge by said means, a stiffening member secured to the central portion of one side of the diaphragm, a sheet metal stylus holder secured to the central portion of the other side of said diaphragm and including a flat portion secured to said diaphragm and a pair of portions projecting outwardly of the diaphragm, and a stylus secured between said outwardly projecting portions by being gripped between them.

11. In a sound reproducer, a supporting means, a diaphragm supported by said means, an annulus, a spring clip holding said annulus tight against said diaphragm in spaced relation to said supporting means to produce a plane radial tension in the diaphragm, and a stylus holder connected with said diaphragm.

12. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, an annulus held tight against said diaphragm in spaced relation to said supporting means to produce a plane radial tension in the diaphragm, a stylus holder connected with said diaphragm, damping means, and means pressing said damping means against the diaphragm.

13. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow rigid cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly

of said supporting means, tensioning means pressing the free edge of said member against the diaphragm and tensioning the latter, a stylus holder connected with the diaphragm, damping means, and means pressing said damping means against the diaphragm.

14. In a sound reproducer, a supporting means, a diaphragm comprising a sheet supported against said means, a rigid annulus held tight against said sheet to tension the diaphragm, a stylus holder connected with said diaphragm, and a damper engaging the diaphragm within said annulus.

15. In a sound reproducer, a supporting means, a diaphragm supported by said means, an annulus having an edge against said diaphragm, a spring clip spanning said supporting means and causing the edge of the annulus to press against the diaphragm and produce a plane radial tension in the latter, and a stylus holder connected with the diaphragm.

16. In a sound reproducer, a supporting means, a diaphragm supported at its edges by said means, a shallow cup-like member disposed with its open side toward the diaphragm and with its free edge against the diaphragm inwardly of said supporting means, tensioning means pressing the free edge of said member against the diaphragm and producing a plane radial tensioning of the latter, a stylus holder connected with the diaphragm, damping means, and said shallow cup-like member pressing said damping means against the diaphragm.

17. In a sound reproducer, a supporting means, a diaphragm supported by said means, a shallow rigid cup-like member completely closed at one side and disposed with its open side toward the diaphragm and with its free edge against the diaphragm, tensioning means pressing the free edge of said member against the diaphragm, and a stylus holder connected with the diaphragm.

18. In a sound reproducer, a supporting means, a diaphragm supported by said means, a rigid member having an edge against said diaphragm, a spring clip spanning said supporting means and causing an edge of the member to press against the diaphragm and tension the latter, and a stylus holder connected with the diaphragm.

19. In a sound reproducer, a supporting means, a diaphragm supported by said means, an annulus having an edge against said diaphragm, spring means causing the edge of the annulus to press against the diaphragm and produce a plane radial tension in the latter, and a stylus holder connected with the diaphragm.

20. In a sound reproducer, a supporting means, a diaphragm supported by said means, a member having an edge against said diaphragm, spring means causing the edge of said member to press against the diaphragm and produce a plane radial tension in it, and a stylus holder connected with the diaphragm.

ERNEST W. FRANCK.